Path Dependence and the Korean Keyboard

by

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Abstract

The paper recounts the evolution of the Korean keyboard as a case in which disadvantages of the inherited standard is turned into a non-issue with the advancement of auxiliary technologies. The persistence of an inherited standard, when a superior alternative is available, is usually regarded as market failure. If the transition cost to the new standard is such that the net gains from transition are insufficient, however, the situation is unfortunate, but not market failure. The situation may change over time. If the net gain from the alternative standard increases, or transition costs to new the alternative decreases, or both, the situation turns into one where entrepreneurs can make profit by making the transition. Where appropriate an institutional reform may lower transition costs substantially. There is an additional possibility of technological changes making the transition unnecessary. In the case of the Korean Keyboard, changes in auxiliary technologies have rendered disadvantages of the inherited standard innocuous. The case provides a cautionary tale against the temptation to drastically alter a seemingly hopelessly inferior inherited standard. The lesson of the Korean Keyboard applies to Japanese and Chinese Keyboard with a greater force.

I. Introduction

The concept of path dependence has gained much currency in economics and public policy arenas. Given the a-historical approach of neoclassical economics, the idea that history matters has been viewed as refreshing. Path dependence as a new class of market failures has rendered it policy relevant.

The paradigm of path dependence is QWERTY, prevailing over other superior keyboard arrangements, such as Dvorak Simplified Keyboard (DSK), only because it had an early start and historical accidents such as an exceptional typist using it winning speed-typing competitions.[1] QWERTY was designed to slow down typing, to deal with the problem of mechanical arms tangling from typing too fast. By the time tangling of typing arms was no longer an issue, with the advent of the ball typewriter or with the word processor on PC, QWERTY was already well established as the standard, with all the advantages of network externalities. QWERTY has persisted even when a superior alternative exists such as DSK.[2] David (1985, 336) concludes that "competition…drove the industry prematurely into standardization *on the wrong system*…. due to learning and habituation." The popularity of the concept of path dependenc arises from the implication that some kind of government intervention could improve upon the market outcome.[3]

Surely, history matters in the sense that today is preceded by yesterday and what we do today is severely circumscribed by choices made in the past. But does it necessarily follow that path dependence results in market failure? Liebowitz and Margolis (1995; LM

[1] David (1985)
[2] Despite the evidence that the efficiency gain from switching to DSK was such that the cost of retraining typists can be recovered in matter of days, (and it became possible to switch between QWERTY and DSK with a click of the mouse.
[3] "In a QWERTY world, markets cannot be relied upon to get things right." (Krugman 1994, 235) The envisioned intervention may range from picking a winner to underwriting the experimentation of all promising technologies.

hereafter) have challenged the idea of path dependence as market failure. LM suggest that there are three types of path dependence: (1) One type of path dependence, stemming from arbitrary decisions in the past—such as driving on the right (vs. on the left), or using chopsticks (vs. fork and knife)—cannot be judged to be inferior to other possible outcomes based on alternative decisions. Certainly, this type, dubbed the *1st degree path dependence*, is not market failure.

(2) Of course, we may not be as indifferent to path dependant practices or standards. Tough when people made choices they were doing the best they could, based on the available information, it is entirely possible that what has become the prevailing standard may be judged regrettable in light of newly available alternatives. That is, people may come to believe that they would make a different choice were they given a chance. The story of QWERTY is meant to describe precisely this type of situations. Is this an instance of market failure, a market failure that can be corrected through a public choice? This is the prevalent interpretation. However, if the cost of switching is sufficiently high[4], and there is no profitable way to improve the situation, the persistence of the apparently less inefficient standard cannot be regarded as market failure. LM believe that QWERTY this type, the *2nd degree path dependence*.[5]

[4] Or the cost of maturing the promising technology in question to a sufficient level of maturity to make it economical is too high.

[5] The alleged superiority of DSK over QWERTY is suspect; The Navy study cited by David (1985), which is supposed to establish the superiority of DSK, is questionable in methodology. Besides, there is contrary evidence from a study conducted by the General Services Administration. (Liebowtiz and Margolis 1990) Finally, even if DSK were marginally better than QWERTY, it could not have overcome the costs of switching. Considering all these, it is unwarranted to say that QWERTY is a paradigmatic example of path dependence resulting in a market failure. LM further argue that other cases cited by the subscribers to third degree path dependence (e.g., VHS over Betamax, internal combustion engine over steam engine for cars, the light water nuclear reactor over the gas graphite reactor or the heavy water reactor, etc.) are so many "just-so" stories that cannot stand close scrutiny. (Liebowtiz and Margolis 1994)

(3) For path dependence to be truly a market failure the situation must satisfy two conditions: a choice made earlier has turned out to be regrettable, and there is a superior alternative, migration to which would mean sufficient expected gains, net of switching costs. LM observe that this type, dubbed the *3rd degree path dependence*, would be true market failure. However, they argue that it is difficult to find because the market system tends to eliminate it as entrepreneurs try to capture the profit from efficiency gains. LM are extremely skeptical of the existence of a real life example of the 3rd degree path dependence: Is there at least one example of market failure due to path dependence, an example in which an inferior technology (or standard) persisted in the face of an economically superior technology (or standard)?

In trying to meet the challenge of LM, Choi (2008) identifies a case of path dependence that is neither the 2nd degree, nor the 3rd degree—the case of Korean Alphabet from the mid 15th century to the mid 20th century. The story is usually told as follows: The Korean alphabet, *Hangŭl*, is a set of 28 phonetic scripts invented by a king. It was easy to learn and was far more suitable for recording Korean language than the dichotomous writing system then in use—classic Chinese as the official script and an auxiliary system of writing, *Idu*, based on modified Chinese characters to render spoken Korean. Nevertheless, for nearly five centuries the Korean Alphabet was mostly neglected.[6] If transition costs (stemming from network effects) were not significant and the expected efficiency gains were great, and yet the inferior standard persisted, isn't it clearly a case of the 3rd degree path dependence? Choi reasons that the persistence of the inferior system of writings was due, instead, to institutional barriers in the form of the

[6] The Korea Alphabet was readily adopted by those who would have remained illiterate under the then existing system of writings, viz., the less educated and women.

political system based on recruiting ruling elites and their functionaries. When Japan colonized Korea in the beginning of the 20th century, Lee Dynasty's institutional barrier against the Korean Alphabet was destroyed. But another institutional barrier was put in its place as Japan forced her own writing system on Koreans. That the marginal existence of Korean Alphabet was solely due to institutional barriers is proven by its universal adoption of the Korean alphabet when the institutional barriers were removed, with the liberation of Korea after the Japanese surrender in 1945. Choi argues that the case of the Korean Alphabet is a separate type, dubbed the *4th degree path dependence*, for which institutional reform as a policy can be meaningfully discussed.

The four types of path dependence seem to be interrelated through technological changes. The 1st degree path dependence, based on some arbitrary choices in the past, is largely a matter of indifference. The appearance of an apparently superior alternative changes the situation into other types. If the transition cost is sufficiently high, it will become the 2nd degree path dependence, regrettable but not worth changing. If the transition cost is insignificant, or if the potential gain from transition is sufficiently large to overcome the transition costs, it becomes the 3rd degree path dependence, in which the transition to a more efficient standard tends to be effectuated by entrepreneurs (not necessarily spontaneously). If the transition cost is insignificant, yet if there are institutional and political obstacles to transition, it becomes the 4th degree path dependence, which may call for institutional reforms. Do these exhaust all possibilities?

The purpose of the paper is to examine the history of the Korean keyboard as another possibility in which the 2nd degree path dependence is rendered the 1st degree path

dependence with the appearance of complementary technologies. The case may further temper the *dirigiste* impulse.

II. The Korean Typewriter

After the liberation of Korea from the Japanese Colonial rule, during which Korean language had been suppressed, the Korean alphabet, *Hangŭl*, was adopted as the national script as a matter of course.[7] With institutional barriers removed and without political opposition, the 4th degree path dependent turned into the 3rd degree path dependent, which in turn rather quickly into the 1st degree path dependent. The awareness of new possibilities (the availability of new technologies in typewriter), soon transformed the situation into the 2nd degree path dependence, however.

Typewriter was one of those new things Koreans noticed when the American Military Rule (1945-1948) replaced the Japanese colonial rule. Traditional record keeping was of two kinds—handwriting or printing by type-setting.[8] As noted previously, Koreans were forced to adopt Japanese system of writing under Japanese colonial rule and Japanese did not have a typewriter. Even though Japan was an industrialized power, but the Japanese writing system, consisting of two sets of 51 syllabaries (plus two sets of two additional symbols for accents) and mixed use of some three thousand Chinese characters, made mechanical typewriter impossible.[9] Unlike the neighboring countries Koreans had phonetic alphabet (24 characters), recently adopted as the official script, that is suitable

[7] Hardly anyone advocated the revival of the cumbersome writing system of Lee Dynasty made of classic Chinese and *Idu*.

[8] Multiple copies were made using carbon paper, or stencil, based on handwriting. These have been replaced by copiers and printers for PCs.

[9] The problem is even more difficult for a Chinese typewriter that must render a minimum of several thousand characters for common texts. Japanese and Chinese had the 2nd degree path dependence as far as typewriting is concerned and skipped the process of mechanical typewriter, until electronic word processors came to their aid.

for mechanical typewriter. (See Appendix A) The first Korean typewriter was invented in 1949 by Dr. BW Gong, an ophthalmologist.[10] Soon, many competing typewriter designs followed.

An effective Korean typewriter cannot be made by merely replacing Latin typefaces on the striking arms in a regular American typewriter with Korean typefaces.[11] Initial attempts to devise an effective Korean typewriter revealed a number of technical challenges that were not apparent when the record keeping was mostly done by handwriting and books published by typesetting. The following features of *Hangŭl* posed particular difficulties: (1) The custom of writing vertically; (2) The custom of the mixed use of *Hangŭl* and Chinese characters; (3) The custom of fitting a syllable into a box of the same size.[12] Let me briefly explain what the technical difficulties were and how solutions to the problems influenced the design of the Korean keyboard (and the use of *Hangŭl* itself over time.)

III. Problem of typing vertically

The custom of writing vertically was a continuation of the convention of Chinese writing system then in use and adopted at the time of the invention of *Hangŭl*.[13] The custom continued well into the 1950s and beyond. In the age of hand-writing, writing vertically is

[10] The typewriter was manufactured by Underwood Typewriter Company of New York, according to Gong's design. Gong, growing up under the Japanese rule, had to learn the Korean Alphabet in 1945 after the liberation of Korea. (Gong, 1989) He became interested in typewriter after being frustrated with preparing his lecture notes in the absence of medical textbooks. All textbooks were in Japanese, including the one he himself had written.

[11] Gong states that he is not truly the first one to invent Korean typewriter. The honor is attributed to Lee Won Ik and Song Giju. What he invented was an effective Korean typewriter, improvement of which became his lifetime passion. Previous attempts were merely replacing the Latin Alphabet of American typewriter with Korean Alphabet.

[12] Gong 1989.

[13] King Sejong, the inventor of the Korean Alphabet, knew that writing can be done vertically or horizontally. At the time, Mongols and Jurchens wrote their script vertically and Tibetans and Indians, horizontally. Apparently, he chose to follow the Chinese convention.

the 1st degree path dependence. Can the convention be continued in the age of mechanization?

Technically, it is not impossible to make the Korean typewriter to type vertically, if one is willing to put up with the inconvenience of seeing the letters sideway while typing. An earlier attempt (1914?) to the Korean typewriter by Lee Wonik, a Korean immigrant in Hawaii, actually retained the tradition of writing vertically. He simply replaced the typefaces of the American typewriter with *Hangŭl* typefaces, placed sideway. All that one had to do was to turn the page 90 degrees to the right after finishing typing—voila, *Hangŭl* typewritten vertically! To use this typewriter, however, the typist had to tolerate that while typing words were placed sideway, (ignoring many other serious issues discussed below.)[14] But not being able to read what one types was a major handicap.

The issue, however, was resolved by the gradual change of convention—from writing vertically to writing horizontally. There was a time, in the 1950s and 1960s, when people freely wrote, (and books and newspaper printed), either vertically or horizontally. At the time, it was not easy to guess which side of the book is the front cover, a minor inconvenience.[15] Over time, however, the convention of writing horizontally came to dominate the convention of writing vertically. People who perceived the convention of writing horizontally as the 3rd degree path dependence pushed for the change. Inventors like Gong who ignored the convention and marketed a typewriter that typed horizontally certainly had a significant role in the change of convention.

IV. Problem of Mixed Use of Korean Alphabet and Chinese Characters

[14] BW Gong (1989) also examined the typewriter by Song Kijoo dating from the 1930s that types the Korean Alphabet vertically.
[15] Even today, one may occasionally see posters written vertically in political or labor union rallies.

In the post-liberation Korea, there was a heavy mixture of Chinese characters in Korean writings. Highly literate people wrote nearly wholly in Chinese.[16] Even those who used Korean alphabet used it to record unique Korean suffixes and colloquial expressions, impossible in Chinese. This is a legacy of the past.

Since the invention of the Korean alphabet through the mid 20th Century, Koreans had trichotonomous writing system, consisting of classic Chinese (in all state documents and much literary output), *Idu* (a set of Chinese characters to render Korean suffixes and other sounds used in some commercial and legal documents)[17], and *Hangŭl* (in private uses especially by women and the illiterate, in Chinese). The trichotomous system was wholly replaced by the Japanese writing system (consisting of Japanese syllabaries and Chinese characters) during the Japanese rule, while the suppressed *Hangŭl* was kept alive by patriots. In the post-liberation Korea, *Hangŭl* replaced the Japanese syllabaries, but the mixed use of Chinese character continued.

How can one make a typewriter that can type both *Hangŭl* and Chinese characters? The technical difficulty posed for the typewriter by the custom of the mixed use of *Hangŭl* and Chinese characters could not so be easily overcome. For mixed typewriting, one must invent two typewriters (Chinese and Korean) in one. As we shall see below, the Korean typewriter alone posed some formidable technical difficulties. The difficulties of the Chinese typewriter are many times greater, nay, practically impossible.

For a mechanical Chinese typewriter there must be several thousand keys. In that case, the machine is no long a typewriter that people can use in the office or at home, but

[16] The well known autobiography of Kim Ku, *Baekbum Ilji*, was written nearly wholly written in Chinese and had to be translated in 1945 (some have alleged by the novelist Lee Kwang Soo.)
[17] *Idu* is cruder form than the Japanese syllabaries, in that it mostly retained Chinese characters in their original shape. *Idu* should have been replaced by Korean Alphabet when it was first invented if not for political oppositions and institutional barriers.

a very costly typesetting machine that requires a length special training and results in much slower speed.[18] The mixed use was (and is) not a significant problem in printing where typesetters (or specialized typesetting machines) lay out the types. But a typewriter has to have a limited number of keys to be speedy and convenient. That is why Chinese (and Japanese who also have mixed use of Chinese characters) could not have a typewriter until very recently, that is, until the widespread use of electronic word processors.

The choice for Koreans, therefore, was between the continued mixed use and no typewriter and the Korean typewriter only for *Hangŭl*. The developers of the Korean typewriter, understandably, chose to use *Hangŭl* exclusively for the purpose of typewriting, suspending the mixed use of Chinese characters. Writing in Korean using only the Korean Alphabet is perfectly manageable insofar as the pronunciation of all Chinese loan words, (or any loan words from any foreign language for that matter), can be written in *Hangŭl*, phonetic symbols. Printed materials continued to be heavily mixed with Chinese characters. Over time, however, as people have come to be more used to seeing texts written only in *Hangŭl*, even printed materials come to have less and less Chinese characters.[19]

V. The Problem of fitting all characters in a syllable in a box

The most significant technical challenge of a mechanical Korean typewriter was the convention of fitting-all-letters-in-a-syllable-into-the-box (FALIASITB, hereafter). In

[18] H Song 32-33.

[19] There are still people who argue for mixed use for greater clarity, given that Chinese loan words have many homonyms. South Korean government has oscillated between encouraging and discouraging the mixed uses. North Korea chose to use only *Hangŭl* from early on.

contrast, the English alphabet is typed one-letter-after-another-horizontally (OLAAH, hereafter). FALIASITB is a design feature of *Hangŭl*. The reason why the inventor, King Sejong, chose the feature is open to debate: it could be for some linguistic considerations, (i.e., for easier sound recognition); or it could be just to conform to the Chinese convention of writing a character to fit into a box. Either way, FALIASITB is not at all a problem in handwriting.[20] But it is a major issue in designing a mechanical typewriter.

How can one make a typewriter that can type the Korean Alphabet in such a way to fit all letters in a syllable into a square, where a syllable may contain varying number of letters? For example, a syllable may be simply a vowel (as the first "i" in "idiom"), or several letters (as in "squeal"). In *Hangŭl* two letters in a syllable is the minimum; the maximum is six. To fit in anywhere between two to six letters into the same square area, the size of the letters must vary. (It is like trying to fit a syllable with varying number of characters—"I", "gol", "chul", "psalm", etc.—into the same space.) Furthermore, the position and the shape of a letter in the box may have to change, depending on how the letter is used in relationship with others, as well. King Sejong designed some vowels (equivalents of o, u, and ŭ) to be written below consonants and other vowels (equivalents of a, e, and i) to be written to the right of consonants. This design feature of *Hangŭl* influencing the shape and the size of letters further complicates the issues. Consider the following example. In this example, the letter "ㄱ" (that is, the Korean equivalent of the English letter "g" as in "give") takes over 20 different *shapes* and *sizes* to be fitted into

[20] FALIASITB may have contributed to the retardation of further progress in printing technology in Korea, which with vibrant printing industry began to print book using movable metallic types some 200 years before Guttenberg. See P Sohn 1997, 211-212. I think even more important reason is the use of Chinese characters, keeping literacy at a low level.

the box along with other letters in a syllable. The *position* of "ㄱ" varies considerably, as well. (See Appendix B)

How can a mechanical typewriter have several different sizes of a character for each of 24 characters and remain serviceable?[21] And what mechanical ingenuity is needed to position these characters of different sizes in just the right spot, some to the right or some to below the previous letter? In a mechanical typewriter, following the convention of FALIASITB would require 3-4 level of shifting and frequent back-spacing. But such complexity would greatly diminish the convenience of typewriting.

Those who were anxious to introduce a mechanical Korean typewriter came to view FALIASITB as a major stumbling block on the road to progress. Why must Koreans adhere to a standard devised half a millennium ago without any consideration of mechanical typing, when words can be as easily written OLAAH? All that would take is a simple agreement, especially when the official adoption of *Hangŭl* was relatively recent. The advocates of mechanical typewriter regarded the convention had been transformed from the 1st degree path dependence to the 3rd degree path dependence, as it were. Others who were less eager for mechanization of writing were not persuaded. Vigorous debate ensued. The advocates argued for a new convention of OLAAH on the ground of efficiency gains.[22] If the Korean Alphabet is typed OLAAH as in English, there would be none of the difficulties posed by FALIASITB in developing the Korean

[21] The English Alphabet has two sets of 25 characters—the upper case and the lower case. Of course, Latin alphabets are not all of the same size. The letter "i" is considerably narrow than "m" or "w" and there are differences in height between "a" and "g" or "l". And of course, there are differences between upper case and lower case letters. But as long as letters are typed one after another, it is a non-issue.

[22] The advocates of writing OLAAH include Choi Hyun-Bae, Gong Byungwoo, and Joo Yohan. Song, 88-103. The very first man to argue for OLAAH and writing in all *Hangŭl* was Joo Shi-Kyung (1876-1914). It is interesting to note that Joo argue for them even before the technical difficulties of typing Chinese characters or problems associated with FALIASITB became known. Hong-Bin Im, 160.

typewriter (or the teletype). It will be easier to design an efficient typewriter keyboard and the gains in speed would be substantial.[23]

Traditionalists objected to OLAAH on two grounds: (1) OLAAH would take a lot more space than FALIASITB, typewritten texts taking up to 10-15 % longer, wasting paper, and (2) OLAAH is not aesthetic, i.e., typewritten texts with OLAAH would look unconventional.

The advocates of OLAAH responded by saying that the extra space needed to type OLAAH is just about counter-balanced by not having to type the "silent o", an artificial requirement created by FALIASITB.[24] Moreover, OLAAH would make it possible to skip most of "ŭ".[25] Skipping the "silent o" and some "ŭ" would reduce the length of the text by about 10-15%.[26] Moreover, OLAAH had added gains in speed from not having to type the "silent o" or "ŭ", i.e., from typing 10-15 % fewer keystrokes in a typical text.[27] Besides, the primary reason why OLAAH would take more space than FALIASITB is because the Korean Alphabet characters were devised with the view of FALIASITB. For OLAAH the Korean Alphabet characters (especially vowels) can be re-shaped and the presumed disadvantage in appearance would become a non-issue.[28] In this case, OLAAH will mean both gaining in speed and saving of paper. Yes, it would take some getting used to the new appearance, but efficiency gain in easier mechanization and the gain in

[23] A gain of 200 % or more in speed had been suggested. Song.
[24] King Sejong's *Hangŭl* includes a silent "o", to insure that a syllable starting with a vowel will have consonant equivalent filler, hence, the silent "o".
[25] "ŭ" is equivalent to Turkish "i without the dot". In Korean language "*ŭ*" can be skipped with OLAAH some of the time without altering the meaning of the word. Or in the way the "s" in pronounced in the English word "screw" or "school".
[26] Song.
[27] Song.
[28] One may blame that Choi Hyun-Bae's proposal to reshape the Korean Alphabet for OLAAH did not look right. Would Choi Huyn-Bae and his like-minded people have prevailed, had they proposed a more pleasing shape of letters? No one knows.

speed were well worth the costs.[29] In the end the debate was decided in favor of the tradition, FALIASITB.[30] The situation must be classified as the 2nd degree path dependence.

VI. Evolution of Korean typewriter

Once it was decided that Koreans should keep the tradition of FALIASITB, the next issue became how to devise a typewriter that can accommodate the two conflicting goals—viz., FALIASITB and the speed of typing.

For example, the primary design goal of the first mechanical typewriter made by Gong Byungwoo in 1949 was speed. Gong chose to follow FALIASITB only loosely, by using only one set of typefaces for all consonants in the "beginning sounds" regardless how many letters were in a syllable. Similarly, he used one set of typefaces for all vowels (the "middle sounds") and another set of typefaces for all consonants in the "ending sounds", with some exceptions for complex consonants in the end. This so-called "3-set-system" minimized the number of keys necessary in his typewriter, with the result of reasonable training time for the typist, and high speed for a proficient typist.[31] One necessary consequence of Gong's approach was that syllables were fitted into boxes of varying sizes and shapes, depending on the number of letters in a syllable. That is, some

[29] At this point, one may wonder whether Koreans would not have been better off by simply adopting the Latin alphabet, with some modification, as Turks have done. The change would take some getting used to, but the problem associated with the typewriter would have been solved in one stroke. This, however, would have appeared very unpatriotic to the people just liberated from the brutal Japanese domination that tried to wipe out any vestige of things Korean.

[30] Some linguists have claimed that FALIASITB is not only for the familiar appearance, i.e., aesthetics, but has certain linguistic advantages. Gong initially sided with OLAAH, but later changed his mind and decided that FALIASITB is an integral part of Korean alphabet.

[31] Gong altered the keyboard arrangement over time to allow for greater speed in typing. Gongs typewriter was actually two typewriters in one—a Korean typewriter and an English typewriter. One could switch between the two by pressing a key. The keyboard arrangement for the English typewriter was the conventional QWERTY.

syllables were taller and/or wider than others.[32] The text produced by using Gong's typewriter was perfectly readable, but it was not at all like the customary printed text.

Another developer of the Korean typewriter, Kim Dong-Hoon, emphasized, instead, the aesthetics as the primary design goal. He adopted the "5-set-system", which tried to meet more closely the requirement of FALIASITB, varying the shapes and sizes of letters in a syllable as much as possible in a mechanical typewriter.[33] Using Kim's typewriter, one could produce a text that looks reasonably close to the printed text. But it suffered a major disadvantage in speed, as one has to do a lot of shifting, and even frequent backspacing to produce a text. Kim's typewriter also required much longer training because of its complexity.

With the Korean custom of FALIASITB, the keyboard design is much more complicated than just arranging the keys for speed alone, as between QWERTY and DSK. In the Korean keyboard design, even the number of keys was in dispute, resulting in up to eleven competing keyboard designs.[34] Within each typing system design, reflecting different compromises between aesthetics and speed, there is the question of how to arrange keys to increase typing efficiency.

The two typewriters emerged as the dominant and competing standards—Gong's and Kim's. Gong's typewriter was adopted in the early 1950s by the Army and in some government offices such as the ministry of education; later others who cared more about the appearance of the text adopted Kim's typewriter. The market share of Gong's typewriter was much greater than that of Kim's, partly reflecting the early start of the former and partly the user's preference for speed. But Gong's standard could not quite

[32] Song claims that the text produced by Gong's typewriter actually enhances the readability of the text.
[33] H Song, 15.
[34] H Song, 45.

vanquish Kim's standard; apparently, many people thought use of Gong's typewriter means too much of a deviation from the familiar FALIASITB.

In 1969, the Korean government tried to break the stalemate, not by choosing one of the two as the standard, but by coming up with its own keyboard.[35] The standard proposed for the typewriter, with so-called the "4 set" system, was supposed to be a compromise between Gong's and Kim's. However, many users found it an unacceptable compromise. The government proposed "4 set" system did not have the speed of Gong's, nor did the text have the pleasing appearance of Kim's, but just as complicated to operate. It was a typical bureaucratic bungling. Despite the government's considerable effort to promote the newly proposed standard—through the procurement program for government offices, the army, and public schools—the "4 set" system for the typewriter was shunned by users and gradually fell into disuse. [36] Apparently, not all coordinative solutions are equally good; some are inherently inferior. The government promoted standard failed to supplant the then two competing designs. Typewriters by Gong and Kim were in continued use.

VII. Korean Keyboard in the Age of PCs

The advent of increasingly powerful PCs brought new possibilities in the Korean keyboard design. For the technical difficulties posed by FALIASITB for the mechanical typewriter became a non-issue in the age of the PCs with electronic word processor. As the word processor can be programmed to confirm the output of typing to FALIASITB,

[35] The government standard was devised by the Korea Advanced Institute of Science and Technology (KAIST). H Song, 54-69. See also BW Gong. The US also had two separate standards—one for the typewriter, QWERTY with lower and upper cases, and one for the teletype, all caps and no lower cases.
[36] See H Song, 226, for comparative studies. More on the government sponsored standard for the teletype see below.

by varying the size and the location of the Korean fonts, depending on how many and which letters are in a syllable, there is no longer any need to choose between the speed and the appearance. The designer of the keyboard can now concentrate on arranging the keyboard to maximize the typing efficiency.

Consequently, a number of competing keyboard designs for the PC based on MS-DOS and Mac OS emerged in the early 1980s. Gong continued to revise the keyboard design to improve ergonomics and speed.[37] By the mid 1990s, however, the government standard KS X-5002, (a revision of the government standard for teletype keyboard introduced in 1969), became the *de facto* Korean keyboard standard for the PC.[38] Competing designs of the PC keyboard, including Gong's, were quickly vanquished. The main reason for this was that Microsoft-Korea adopted the government proposed standard, KS X-5002, for its Korean version of MS-DOS. The current standard Korean keyboard has been path dependent on the choice made by Microsoft. But the arbitrariness of choice does not make it a market failure. There is no evidence that vanquished competing designs were clearly superior. The current situation, therefore, may be called the 1st degree path dependence.

Some argue even today a superior keyboard design is possible. Some complains are about the readability of the output.[39] But this is no longer a complaint about the keyboard design, but a complaint about the desirability of strictly adhering to FALIASITB. But

[37] "3-set" design was followed by "bunching 3-set" design. In addition, he developed his own word processors to work effectively with his own Korea keyboard design.
[38] In 1982, Korean government proposed the standard computer keyboard, called KS C5715, a "2 set" system derived from the teletype standard. In 1992, KS C5715 was renamed as KS X-5002. When the Korean government proposed the standard keyboard for the teletype—the "2 set" system—there was no other extant competing standard. The government proposed standard for telex was designed solely for speed, ignoring the convention of FALIASITB. Incidentally, the keyboard arrangement of the government standard for teletype appear to have shared the design principles of DSK, placing all vowels on one side and all consonants on the other side, presumably for greater efficiency.
[39] Hyun Song. Song is in fact arguing against the strict adherence to FALIASITB.

with today's technology, the complaints are about the font design, which the PC can easily accommodate. One can easily choose among a variety of fonts, some of which deviate considerably from FALIASITB.

Other claims are about (1) the efficiency of the keyboard arrangement and (2) the "ghost" problem. The "ghost" problem refers to the visual confusion arising from the fact that as letters are typed, characters on the PC monitor would keep on changing until all letters in a syllable are typed, when the computer program will finalize the shapes and positions of the letter, confirming to FALIASITB.[40] Whether or not the ghost problem is significant enough for the user to be willing to incur the switching costs is difficult to judge.

Some have claimed that a keyboard design for great gain in speed is still possible. The potential gain may come in part from better ergonomic arrangement of keys, and in part by taking advantage of the convention of FALIASITB, in which if keys are suitably arranged, it is possible to strike two or more keys simultaneously, (consonant + vowel + consonant), gaining speed (and avoiding the "ghost" problem at the same time).[41] Some claim that the gain in speed is such that there would be net gain even after the switching costs. For example, Matthew Y. Ahn, a retired Anglican minister, recently obtained a patent for his Korean keyboard design, APHK.[42] Ahn claims that APHK is superior to the existing standard Korean keyboard, KS X-5002, in terms of better ergonomics, gains in speed, and eliminating what he calls the "ghost" problem.

[40] An example of the ghost problem is as follows: 오소서 is typed by the following key strokes ㅇ ㅗ ㅅ ㅗ ㅅ ㅓ. But as they are typed, they appear successively as ㅇ, 오,옷, 오서, 오섯, 오소서. There is another, related, quirk in Korean word processors. A backspacing eliminates the entire preceding syllable, instead of eliminating the last typed letter.

[41] Striking multiple keys in Korean typing is possible because all letters in a syllable go to different locations and it does not matter in what order those characters are typed.

[42] Matthew Y. Ahn, 2000.

Ahn is fully aware that the promised speed gain (about 30%) was not enough overcome the switching costs from QWERTY to DSK.[43] He claims that the advantage of APHK over KS X-5002 is far greater than that of DSK over QWERTY, sufficiently greater to overcome transition costs. Ahn has made numerous attempts to document the superiority of APHK.[44]

Interestingly, the advent of the electronic word processor that has not only rendered the problem of devising a mechanical typewriter conforming to FALIASITB a non-issue, but also rendered manageable another problem, viz., the mixed use of Chinese characters. While typing Chinese characters is not as easy as tying the Korean Alphabet, it is not impossible any more.

After all, Chinese (and Japanese) nowadays use the electronic word processor to "type" Chinese characters.[45] The most common way of typing Chinese is to enter the sound of Chinese words, using the Latin alphabet using the QWERTY keyboard, and then select among homonyms brought up by the word processor.[46] The word processor then will produce the selected Chinese characters as output. A less common, but speedier typing (for the proficient) is to use the Chinese keyboard made of elements of Chinese characters and let the word processor combine the input into correct characters by

[43] Ahn, therefore, would agree with Liebowitz and Margolis that the dominance of QWERTY is not the 3rd degree, but the 2nd degree path dependence.
[44] But is his estimation of transition costs and speed gains reliable? Interestingly enough, recently some Korean teenagers won international competition in speed texting, using the current standard keyboard!
[45] Chinese and Japanese have largely skipped the stage of mechanical typewriter, given the technical difficulty of difficulty of devising one, and leapfrogged into the stage of electronic word processing. The advent of PCs has turned a situation of the 2nd degree path dependence into the 1st degree path dependence for Japanese and Chinese.
[46] Rev. Ahn has suggested that Chinese should use the Korean keyboard for the purpose, instead of the English keyboard, arguing that simultaneous striking of multiple keys is more suitable for the Chinese language.

appropriately deciding the shape, size and the location of the elemental input, (in a way somewhat similar to Korean word processor handle input to confirm to FALIASITB).

A Korean word processor can accomplish the same by entering the Korean pronunciation of Chinese characters using the Korean alphabet and then select among homonyms presented by the word processor, when instructed to do so. Indeed, some have welcome the new opportunities observing that the mixed use of Chinese and Korean scripts enhances the precision of the language.[47] There is no institutional barrier. The market will chose the winner between the mixed use and the exclusively *Hangŭl* use.

Had the technology for mixed typing available from the 1950s, when the proportion of population literate in Chinese was much higher, in all probability, Koreans would have opted for mixed typing. Now, when the proportion of population literate in Chinese is much lower, it is not clear whether the mixed use will catch on. But it can remain as an option.

VIII. Concluding Remarks

Path dependence is ubiquitous. There are four types of path dependence: path dependence to which we would indifferent (the 1st degree), path dependence which is not worth changing (the 2nd degree), path dependence which will be spontaneously "corrected" (the 3rd degree), and path dependence which will be spontaneously corrected only with institutional/ political reforms (the 4th degree). There is no market failure. There is only institutional failure. The existence of a promising alternative, therefore, does not mean that there should be collective action to make the switch. The enthusiasm for path

[47] The common estimate is that over 80% of the Korean vocabulary is Chinese character based words, whether adopted from Chinese sources, or Japanese sources, or Korean sources.

dependence as a newly discovered specie of market failures (in QWERTY, VHS, etc.) is premature.

The evolution of Korean Keyboard reveals complex processes of dealing with nested path dependences. As technologies change, path dependence of a type may turn into another type, and then into yet another. What had been the 1st degree path dependence in the age of handwriting had to be reexamined with the possibility of mechanical typewriter. Difficulties for a mechanical typewriter include the conventions of writing vertically (instead of horizontally), the mixed use of Korean alphabet and Chinese characters (for which mechanical typewriter was impossible), and certain design features of the Korean alphabet, FALIASITB. Had all the conventions been kept, the Korean typewriter could not have been made and Koreans would have had to rely on handwriting for much longer—the 2nd degree path dependence. As it was, Koreans quickly adopted the convention of writing horizontally—the 3rd degree path dependence. The mixed use of Chinese character was also suspended, for the purpose of typing—the 3rd degree path dependence. But FALIASITB was kept, after vigorous debates over whether a switch should be made to OLAAHH—the 2nd degree path dependence.

Adherence to FALIASITB forced typewriter designers to seek different compromises. Some typewriters adhere to FALIASITB closely, at the cost of speed, while others emphasized speed, following FALIASITB only loosely and sacrificing the appearance. It was inevitable that competing keyboard designs mechanical typewriter coexisted, catering to different types of users. The government's attempt to establish a unified (compromise) keyboard design for typewriter failed, as it served neither the speed nor the appearance.

The advent of PCs and electronic word processor rendered FALIASITB less of an issue. A word processor can appropriately vary the size of letters and place them in appropriate places in the "box". The 2nd degree path dependence was turned into the 1st degree path dependence. Under the circumstance, the choice of keyboard would be based on ergonomics and speed. A good candidate was Dr. Gong's keyboard design as his emphasis on typewriter design was speed. Instead, a revised version of government standard for teletype became the standard keyboard, on the account that Microsoft-Korea, the dominant player in PCs, chose the government standard. It has been widely accepted. Comparing, in terms of efficiency, the current Korean standard keyboard with that of Gong's or Anh's would be similar to comparing QWERTY with DSK—the 2nd degree path dependence.

It is interesting to note that, while the advent of PCs has allowed Koreans to overcome the problems arising from FALIASITB, it has made typing possible for the Chinese and Japanese, who skipped entirely the stage of the mechanical typewriter owing to the complexity of their systems of writing. PCs has allowed Koreans to have both the speed and the customary appearance; it has saved the Chinese and Japanese much callus on their hands.

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APPENDIX A: THE KOREAN ALPHABET*

Basic consonants	ㄱ **(g)** ㅋ **(k)** ㄴ **(n)** ㄷ **(d)** ㅌ **(t)** ㅁ **(m)** ㅂ **(b)** ㅍ **(p)** ㅅ **(s as in smile)** ㅈ **(j)** ㅊ **(ch)** ㅿ **(z)** ㅇ **(silent)** ㅇ **(ng)** ㅇ **(kh?)** ㅎ **(h)** ㄹ **(r or l)**
Basic vowels (Here ㅇ is a silent "o")	으 **(ŭ)** 이 **(i)** ㆍ **(lower "a")** 아 **(a)** 야 **(ya)** 어 **(ô)** 여 **(yô)** 오 **(o)** 요 **(yo)** 우 **(u)** 유 **(yu)**
Other sounds represented by using the basic consonants and vowels	ㄲ **(c as in Spanish casa)** ㄸ **(t as in Spanish Antonio)** ㅃ **(p as in Spanish padre)** ㅆ **(s as in sound)** ㅉ **(between j and z)** **(f)** 의 **(ŭi)** 에 **(e)** 예 **(ye)** 애 **(ä)** 얘 **(yä)** 외 **(ö)** 왜 **(öä)** 위 **(ü)** 워 **(wô)** 웨 **(weh)** 와 **(wa)**

*When *Hangŭl* was invented in 1443, the *Hangŭl* had the following features.

1. There were 28 letters in the Alphabet. Four (ㅇ, ㆁ, ㅿ, and ㆍ) have fallen into disuse and currently Koreans use only 24, not counting additional sounds represented by combining two more more basic characters. There were other composite consonants that are no longer in use, such as ㅱ (f).

2. Each syllable formed a separate block. A syllable has three possibilities: (1) a vowel, or (2) a vowel and a consonant, or (3) a consonant, a vowel and a consonant. Korean letters for vowels are designed to be used in combination with preceding consonant. The case of a syllable with only a vowel is by inserting filler, the "silent o". The "silent o", which acts like the Spanish "h" as in "hacienda" or the English "h" as in "honest", was used before all vowels not proceeded by a consonant.

3. The tone of each syllable was represented by varying number of dots on the left-hand side of the syllable-block. The tonal dots (no dot, one dot, and two dots) are no longer in use. In modern usage, the tonal representation is no longer used.

4. At the time of invention, syllable-blocks were written top-to-bottom, from right to the left. That is, the first syllable-block starts at the top right hand corner followed by the next syllable-block written right below the first. When the first line is finished, the first syllable-block of the second line is written to the left of the first line. Naturally, pages of books written in this way flip to the right.

APPENDIX B: AN EXAMPLE OF DIFFERENT SHAPES AND LOCATIONS OF KOREA ALPHABET "ㄱ"

	A	B	C	D	E	F	G	H	I	J	K
1	가	각	개	갯	까	깨	깽	깩	갂	깍	
2	거	걱	게	계	껙	꺼	꼐	꺽			
3	고	곡	곪	괴	괵	꼬	꾀	꽁	꾁	꽥	꼭
4	구	국	굶	귀	귓	궈	궉	꾸	꾹	꿔	꿕
5	그	극	긁	긔	긧	끄	끅	끎		훅	꿸
6	기	긱	끼	끽						삯	닭